

**TRANSFORMING PAPER WASTE TO PAPER BRIQUETTES: A SUSTAINABLE AND
ECO-FRIENDLY ALTERNATIVE FOR FUEL**

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ABSTRACT

This study investigates transforming paper waste into paper briquettes as a sustainable alternative fuel source, addressing environmental concerns like deforestation and air pollution. The briquetting process converts loose biomass, such as paper waste, into compact briquettes suitable for solid fuel use. By evaluating and improving existing methods, the study aims to reduce waste and environmental impact. It investigates the viability of using paper waste as a renewable energy resource, comparing paper briquettes with traditional wood charcoal in terms of burning time, heat output, and smoke emissions. It also investigates the environmental advantages and disadvantages of paper briquettes, explores optimization of the conversion process, and identifies potential applications in various industries. The study aims to assess paper briquettes as an affordable renewable fuel source for households, hypothesizing that they will burn faster, produce more heat, and emit less smoke than wood charcoal while demonstrating an efficient conversion process. The significance extends to communities, industries, future generations, and researchers. It provides cost-effective, eco-friendly fuel options for communities, new revenue opportunities for industries, and promotes renewable energy for future generations. Additionally, it contributes valuable data for further studies on paper waste conversion. However, the research has limitations, focusing on technical, environmental, and economic aspects without assessing large-scale commercial production or regional variations. The methodology includes gathering materials, sorting, soaking, shredding, compressing, shaping, and drying the paper to form briquettes. Additionally, a calorimeter is employed to measure heat output. Data will be collected through qualitative and quantitative methods, including surveys from community households using a Likert scale to gauge perceptions of smoke emissions compared to traditional charcoal. Overall, this project aims to demonstrate the practical application of recycling paper waste into a sustainable fuel alternative, thereby contributing to improved waste management and environmental sustainability.

The abstract is too idealized

CHAPTER I

INTRODUCTION

Background of the Study

Environmental issues are a prevalent world-wide concern, initiating a need for research to find practical solutions. Paper waste is a significant contributor to environmental problems, such as deforestation.

Researchers have been finding ways to recycle paper waste into renewable energy sources. One widely-used method is briquetting, which transforms loose biomass or other materials into compact, dense blocks known as briquettes. These briquettes can be used as a solid fuel for heating, cooking, and industrial purposes. The briquetting process increases the material's density while improving its handling and combustion properties.

Some studies show that when paper isn't recycled, it leads to more production of virgin paper, which eventually harms the environment (Roberts et al., 2023). Moreover, the incineration of paper for disposal contributes to air pollution, responsible for about 2% of global carbon dioxide emissions (Zhang et al., 2023). Recycling of paper waste into paper briquettes is a stepping stone to addressing more waste management issues and developing sustainable energy solutions.

Our study focuses on advancing previous studies and evaluating the processes and applications. By converting paper waste into paper briquettes, the researchers seek to apply and

possibly improve previous methods to further the effectiveness of converting paper waste into eco-friendly fuel.

Significance of the Study

Communities and Households: This research offers a practical and accessible solution for managing paper waste within communities and households. By transforming waste into a usable fuel, source households can reduce their reliance on traditional fuel, which may be more expensive or less environmentally friendly. This approach also encourages recycling practices at the local level, fostering a more sustainable lifestyle and reducing environmental impact.

Industries and Businesses: For industries and businesses, particularly those involved in waste management, energy production, or manufacturing, the study provides an innovative way to repurpose waste materials. Converting paper waste into paper briquettes can create new revenue streams, reduce operational costs by offering a cheaper fuel alternative, and improve corporate sustainability efforts. Additionally, businesses that adopt this practice can enhance their corporate social responsibility (CSR) profiles by contributing to environmental conservation.

Future Generations: This study plays a crucial role in ensuring a sustainable future. By promoting the use of renewable and eco-friendly energy sources, it helps preserve natural resources and reduce environmental degradation for future generations. The research supports the development of a more sustainable energy infrastructure, which will benefit not only the current population but also those who will inherit the planet.

Research Communities: The study contributes valuable data and insights to the research community, particularly in the fields of environmental science, renewable energy, and waste management. It provides a foundation for further research into the efficiency, scalability, and

broader applications of converting paper waste into paper briquettes. Future researchers can build on this study to explore improvements, alternative methods, and the potential for integrating this approach into larger waste-to-energy systems.

Statement of the Problem

In order to address the issues of waste management and sustainable fuel generation, this study looks into the possibility of turning paper waste into environmentally friendly paper briquettes. The study aims to investigate the feasibility of converting paper waste into a viable energy resource. The ultimate goal is to minimize environmental effects and facilitate the global transition towards sustainable energy sources.

Research Questions:

1. When compared to traditional wood charcoal, how effective is the method of turning waste paper into paper briquettes in terms of:
 - 1.1 Burning time
 - 1.2 Heat output
 - 1.3 Smoke emission
2. What are the possible disadvantages and advantages for the environment of employing paper briquettes made from paper as a substitute fuel source?
3. How can the waste paper conversion process be made as efficient as possible?

4. What are the possible uses and commercial prospects for paper briquettes obtained from paper in different industries?

Research Hypothesis

Based on the research questions, the researchers hypothesize that:

1. When testing and comparing the paper briquettes to traditional wood charcoal, it will be observed that:

1.1 Paper waste as paper briquettes will have lower burning time compared to wood charcoal.

1.2 Paper waste will conduct a higher heat output compared to wood charcoal; and

1.3 Paper waste will generate a lower perception of smoke emission compared to traditional charcoal.

2. The percentage of paper waste volume gathered and amount converted into paper briquettes will result in a cleaner process observed in the ratio of output (charcoal) to input (waste paper).

Scope and Limitations

The research focuses on converting paper waste into paper briquettes, analyzing its technical feasibility, environmental impact, and economic viability. It examines the processes involved in transforming paper into briquettes, including briquetting and pyrolysis, and the specialized equipment needed, such as kilns or reactors. The study also evaluates energy efficiency, greenhouse gas emissions, production costs, market demand, and potential revenue streams.

However, the study is limited in its capacity to assess large-scale commercial production, as well as regional variations in resource availability, infrastructure, and regulations. Additionally, it may not fully account for future advancements in conversion technologies or alternative energy sources. Acknowledging these limitations ensures that the research findings are contextualized accurately and applied appropriately.

CHAPTER II

3 spans

Theoretical Framework

The underpinning of this research study is the Cradle-to-Cradle (C2C) design theory, developed by William McDonough and Michael Braungart, whose core objective is to eliminate waste and pollution by designing products that can be recycled or reused indefinitely. This theory enhances the concepts of circular economy, in which there are continuous cycles of biological and technical nutrients in the environment without destroying the ecosystems while creating economic value (Russell, 2023).

The researchers' study aligns closely with the C2C principle of "Waste Equals Food." By transforming paper waste into briquettes, the researcher can effectively turn a waste product into a valuable resource that can be used as fuel. This approach contributes to a circular economy by reducing the amount of paper waste in landfills, protecting ecosystems, and minimizing environmental impacts (Coruz, 2021). This prevents the continuation of paper waste in piles of landfills, minimizes impacts to the environment, and benefits the economy (Coruz, 2021). Therefore, this study has the potential to address one aspect of the challenge of paper waste through the adoption of the C2C approach. Additionally, the researchers' findings can help advance the challenge toward the far-reaching aim of a circular economy in which resources are used more efficiently and waste is minimized.

Conceptual Framework

The researchers applied treatment to the selected experiment in the study "Transforming Paper Waste into Paper Briquettes," which uses a real experimental and quantitative research methodology. Researchers investigated this hypothesis and produced data that aids the research

~~Explanation~~

to support legitimate findings between the variables by employing a non-equivalent group design, which functions as the procedure's blueprint.

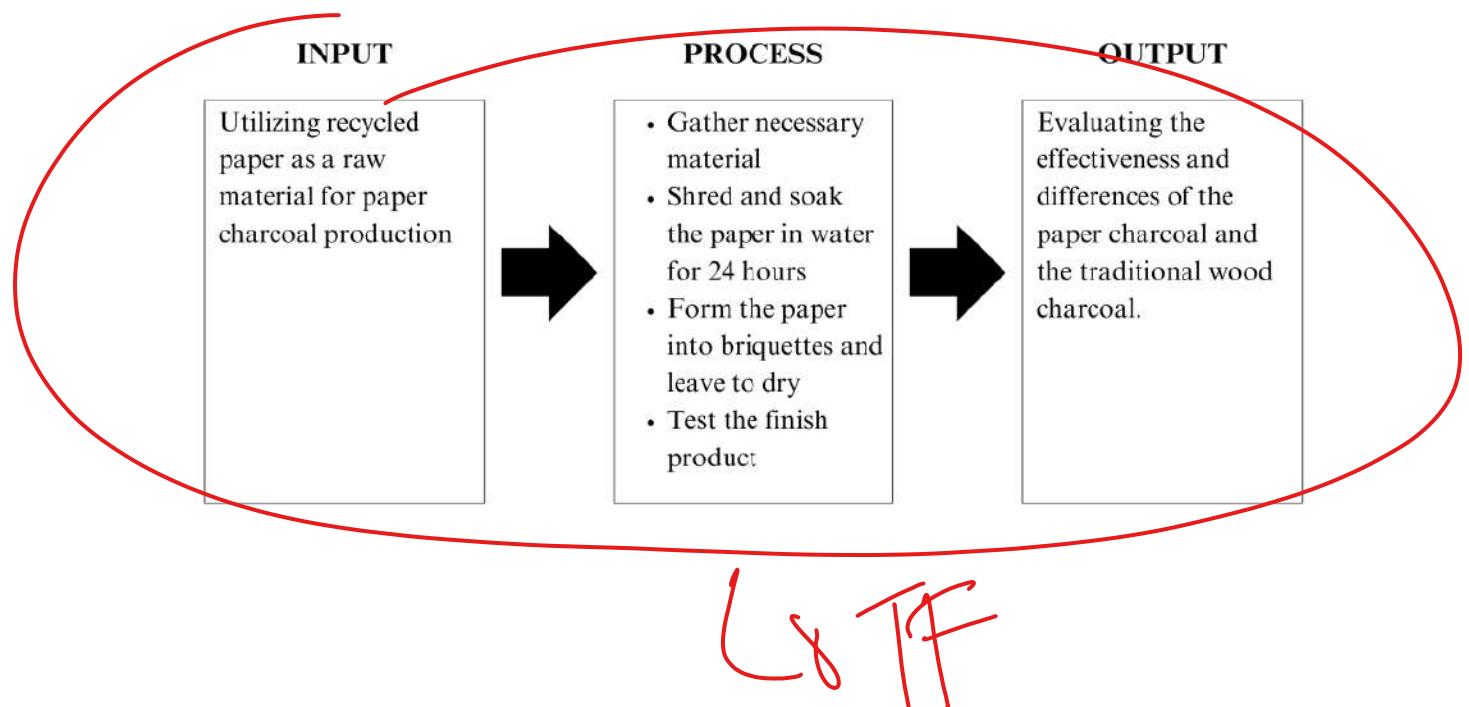


Figure 1.1 outlines the study's variables. It explains how any type of discarded paper can be recycled into paper charcoal. The process involves soaking the paper in water, mixing it with dried leaves, and forming it into balls. After shaping, the mixture is left to dry in the sun. This product can then be used as an alternative cooking fuel, which helps reduce reliance on forest wood for fuel.

Operational Definitions

Briquetting - is the process of compacting loose materials, typically waste products or biomass, into solid, dense blocks. These blocks, known as briquettes, can subsequently be utilized for fuel or other uses (Bokalders, 1986).

Paper waste. Refers to any form of paper that is no longer usable and needs disposing, including newspapers, magazines, office documents, and more (Cambridge, n.d.).

Sustainability. The use of resources to meet our needs today that can be maintained or supported for the long term (Mollenkamp, 2023).

Circular Economy. A circular flow of materials where wastes are reused and repurposed instead of being thrown away (US EPA, n.d.).

Review of Related Literature

A. Paper Waste Management

- Global Paper Waste Production

Global paper waste production remains a significant environmental issue, particularly its contribution to landfills and pollution. In 2020, global paper production exceeded 400 million tons, resulting in approximately 40-50 kg of dry sludge per ton, contributing to vast volumes of solid waste (Quintana et al., 2024). By 2050, total global waste is expected to reach 3539 million tons, with paper waste becoming a larger share of this total (Chen et al., 2020). Recycling paper can significantly reduce the environmental impact by lowering landfill use and greenhouse gas emissions. However, the study also emphasizes that inefficiencies and contamination in recycling processes can limit these benefits. Improved recycling technologies and better waste management are essential to enhance the environmental advantages of paper recycling. (Subak & Craighill, 1999). The recycling rates in the paper sector are around 38%. However, there is a significant potential to increase these rates between 67% and 73% through better recovery practices (Ewijk et al., 2018). By advancing recycling and material efficiency, it is possible to substantially reduce the landfill intensity of paper waste, potentially decreasing it from 331-473 kg of waste per ton of paper to nearly zero (Ewijk et al., 2017). Despite advancements in

recycling, the paper industry remains a major contributor to environmental problems, resulting in the need for urgent improvements in waste management and recovery practices.

- Recycling and Reuse

Recycling is a process that converts the used material into usable after processings. Waste recycling can help to solve the problem of scarcity of raw materials. Recycling rare earth metal plays a significant role in reverse logistics (Swain and Mishra 2019). There is a very subtle difference between ‘Recycling’ and ‘Reuse’. Through recycling, initially, raw materials are extracted from used products that may be used to make the same or new products. ‘Reuse’ is meant for using an object without any reprocessing or treatment; it only elongates the life of an object. At present, Gothenburg in Sweden runs five recycling centers, one of which is specified for reuse. It is calculated that if all five centers would be engaged only for reuse, 2200 tons of waste are to be reduced every year which is equivalent to 800 tons of CO₂ (Ordóñez et al.2019).

Recycling and Reusing waste, as seen in Gothenburg’s efforts, alongs with transforming paper waste into briquettes for sustainable fuel. Both processes reduce waste and environmental impact by repurposing materials that would otherwise contribute to landfill or emissions. Converting paper to briquettes helps reduce reliance on traditional fuel sources, lowers deforestation, and supports a circular economy by turning waste into a valuable resource, much like recycling centers reduce CO₂ emissions by extending the life of objects.

B. Paper Briquettes Production

- Processes of Briquette Production from Paper Waste

Charcoal is a versatile and essential fuel source and is traditionally produced from wood through a process known as pyrolysis (SHULIY, n.d.). According to a survey by the Central

Echo (2011), more than 90% of Filipinos are dependent on charcoal for cooking. While only 1-2% use liquefied petroleum gas (LPG) or kerosene due to the high cost of living. However, research and articles have explored innovative alternatives to wood, such as paper waste, according to studymoose.com (2016) paper waste can be effectively converted into paper briquettes, offering a sustainable and environmentally friendly solution. The process involves collecting various types of paper, including newspapers, craft papers, and cardboard. The paper is then shredded and soaked in water, forming it into briquettes. The paper briquette is then left to dry and can be used as charcoal, providing a viable alternative to traditional wood-based charcoal.

Comedis et al. (2017) research study found that 85% of the researchers agreed that paper briquettes is environmentally friendly, reducing deforestation and avoiding overcrowding landfills. It was also stated that, despite the lower price of wood charcoal, respondents believed that paper briquettes were more profitable. Furthermore, respondents preferred the environmentally friendly characteristics of paper briquettes over its disadvantage of burning quickly and dustily. Because of this, the researchers concluded that 60% of respondents preferred paper briquettes over traditional wood charcoal.

C. Sustainability and Environmental Impact

- Eco-friendly Fuel Alternatives

The transformation of paper waste into briquettes represents a sustainable approach to waste management and energy production. The concept of sustainability emphasizes the need for energy solutions that not only meet current demands but also preserve resources and minimize environmental damage for future generations (IPCC, 2018). Paper waste can be used as a

renewable energy source, to promote resource recovery, and to reduce garbage transported to landfills all of which are in line with the ideals of sustainability.

The environmental benefits of converting paper waste into paper briquettes are twofold: it reduces the amount of solid waste in landfills and provides a cleaner-burning fuel. Paper waste, which is often disposed of in landfills, can release methane, a potent greenhouse gas as it decomposes (Lehmann & Joseph, 2015). By converting this paper waste into paper briquettes, carbon sequestration is enhanced, helping to mitigate the impact of climate change. The use of paper briquettes reduces the need for deforestation, preserving ecosystems and biodiversity that are often destroyed in the production of traditional charcoal (World Health Organization, 2020).

- Carbon Footprint and Emissions

According to an article published by insight (2024), due to the reduced energy consumption and lower environmental impacts associated with the production of paper briquettes, the product has a lower greenhouse gas emissions and carbon footprints compared to the traditional wood charcoal. Landfilling paper waste releases methane, a potent greenhouse gas even more damaging to the environment than CO₂. While, on average, paper can be recycled at least seven times and offers a more sustainable alternative, it still requires energy and resources.

D. Efficiency of Paper Briquettes

- Measuring Caloric Content

Understanding the caloric value of briquettes is essential for estimating their energy output, particularly in emergency situations where alternative fuel sources are limited. According to research published in the International Journal of Research in Engineering and Technology, this knowledge ensures sufficient energy for cooking and heating when traditional resources may not

be available. Similarly, a study from De La Salle University emphasizes that knowing the calorific content aids in logistical planning, helping to determine the appropriate quantity of briquettes needed, thereby avoiding shortages or excess inventory, which is especially vital in resource-constrained situations.

In terms of sustainability, research featured in Springer compares the calorific value of paper briquettes to traditional fuels like coal, demonstrating that briquettes are a greener alternative. This is significant in reducing the carbon footprint during disaster response efforts. Additionally, various articles discuss the importance of optimizing briquette production based on calorific content, as different materials contribute to varying calorific values. Accurate measurement of this content is crucial for improving the overall quality and performance of briquettes, making them more effective in emergency settings.

- Assessing burning time

The burning time of paper briquettes plays an important role in determining their efficiency and suitability as an alternative fuel source. Studies have focused on the combustion characteristics and how different compositions impact the burning time and energy output.

Briquettes made from waste paper combined with agricultural residues, such as groundnut shells, have been shown to offer substantial energy yields. According to Oyelaran et al. (2015), the calorific values of such briquettes ranged between 19.51 to 19.92 MJ/kg, indicating a good energy yield for this alternative for fuel. Moreover, the average burning rates were reported between 0.511 and 1.133 kg/hr, with specific fuel consumption ranging from 0.087 to 0.131 J/g. An optimal composition of 85% waste paper and 15% groundnut shell was found to enhance

combustion characteristics, making this mixture ideal for maximizing both burning time and energy output.

The duration for which briquettes burn is an essential factor for fuel efficiency. Nuna and Putra (2024) found that the burning time for paper briquettes varied from 90 to 114 minutes, with differences attributed to the specific mixture and production conditions. Additionally, Akuma and Precilla (2017) highlighted that factors such as moisture content and the density of the briquettes significantly influenced the ignition time and overall burning time. These findings emphasize that optimizing the production process, particularly in controlling moisture and density, is vital for improving the burning efficiency of paper briquettes.

- Consumer Satisfaction on Smoke Emission

A study conducted by Zannikos, et al. in 2013 "Converting biomass and waste plastic to solid fuel briquettes" discovers that utilizing waste materials such as biomass into briquettes proved to be a viable alternative to traditional fuel sources. This study is relevant to our research since ours also focuses on the discovery they found, but their study focuses on the effects of various materials such as polyethylene terephthalate (PET) and its impact on combustion emissions. Measuring the smoke emissions of briquettes compared to charcoal is crucial to our study since a survey will be conducted on which fuel source produces less smoke. Both our studies aim to transform paper waste into an eco-friendly fuel source.

E. Economic and Social Implications

- Cost-effectiveness

The cost-effectiveness of transforming paper waste into paper briquettes is evident in several studies and projects that emphasize the accessibility of raw materials and the low

production costs. In Zambia, community projects have used recycled paper to produce paper briquettes as an alternative to traditional wood-based charcoal, helping to reduce deforestation and providing a cheaper energy source.

Additionally, in the Philippines, briquettes made from paper and other waste materials were shown to have good energy density, with lower smoke emissions. This method, which involves low-cost machinery, has been proven to be a viable solution for low-income communities, reducing environmental and economic costs associated with traditional charcoal production.

These projects demonstrate that with minimal investment, significant savings can be made in both environmental impact and energy production, making paper waste-derived paper briquettes a cost-effective and sustainable option.

- Social Impact and Community Involvement

A study conducted in 2022 titled “Biochar production techniques utilizing biomass waste-derived materials and environmental applications – A review” experiments various methods of converting biomass waste, including paper waste, into paper briquettes. Out of the eight methods used – pyrolysis, torrefaction, HTC, slow, intermediate, fast, flash, and microwave-assisted pyrolysis, the slow pyrolysis method proved to be the most effective at producing biochar.

Table 2
Pyrolysis processes, operating conditions and the by-product fractions.

Technique	Temperature(°C)	Residence time (s)	Heating rate(°C/s)	Biochar(%)	Bio-oil(%)	Syngas(%)	Ref.
Slow pyrolysis	300-550	hours to days	1-10	35	30	35	(Shahbaz et al., 2020)
Intermediate pyrolysis	450-550	10-20s	10-1000	25	50	25	(Daful and Chandraratne, 2018)
Fast pyrolysis	450-600	< 2s	10-1000	12	75	13	(Thomas et al., 2019)
Flash Pyrolysis	750-1000	0.5s	<1	-	-	-	
Microwave-Assisted Pyrolysis	400-800	-	>1000	-	-	-	(Zaker et al., 2019)
Carcification	> 800	10-20s	1-0.8	10	5	85	(Zaiied et al., 2020)
Torrefaction	450-550	< 2 h	-	75	20	5	(Analina et al., 2022)
Hydrothermal Carbonization	< 200	1-16 h	<1	35	30	35	(Brown et al., 2020)

This study discusses the environmental benefits of biochar, namely improvement of soil health and isolating carbon, while also encouraging community engagement in biochar production initiatives. The researchers state that these processes can open up new areas and opportunities for research by converting waste into a renewable resource, promoting sustainable application and awareness among residents.

An article published in 2023 that focuses on converting paper waste into paper briquettes discusses innovations like Carba, which uses organic waste to produce briquettes. The study uses a waste-to-briquette process: 1. Waste Collection, 2. Waste Processing, 3. Carbonization, and 4. Paper Briquette Production. Waste Collection provides job opportunities, creating local employment that support the local economy and build engagement from the community members in sustainable practices. In addition, the traditional production of charcoal relies on wood sourced directly from forests, resulting in eventual deforestation. By using organic waste as feedstock, this waste-to-briquette process reduces the demand for wood-produced charcoal, promoting the conservation of forest habitats.

The studies on converting paper waste into paper briquettes through biochar production shed light to benefits that relate to our study promoting community involvement and social impact. The 2022 study highlights the importance of community involvement, suggesting that local involvement in biochar production can promote awareness and offer new research

opportunities. The 2023 article harmonizes this by creating a waste-to-briquette process that significantly reduces paper waste, birthing both environmental and social advantages. By providing job opportunities through waste collection and processing, this method encourages locals and promotes community participation. Furthermore, substituting organic waste as traditional wood for charcoal production helps reduce deforestation, contributing to a healthier environment. Together, these studies show how converting paper waste into briquettes addresses environmental issues, encourages community involvement and economic development. The implementation of biochar production and waste-to-briquette processes shows a sustainable approach that benefits society as a whole.

Ethical Consideration

This research puts focus on ensuring the safety and privacy of household respondents. Before starting the study, informed consent will be acquired from the respondents. Strong measures such as coding the respondents' names as numbers in discussing data. The inclusion of respondents' names was made optional, and at the conclusion of the summary, names and other identifiable information were coded.

The researchers must obtain consent from the respondents, informing them the purpose of the study and how their data is to be used. The respondents' information will be kept confidential and their intellectual property rights respected.

Sharing of data is strictly forbidden. The research team only had access to the gathered data, which was securely stored and exclusively available to them. Furthermore, all raw data was promptly erased upon completion of the study, demonstrating the researchers' dedication to maintaining data privacy.

- * The RPL is not contextualized, it is a bit complex for a simple study,
- * Focus on briquette production methods & efficient heating
- * You don't need sub-parts, Tell a story of the start to end of your story, all w/technical BASES,

YSPACF, remove

CHAPTER III

METHODOLOGY

Section 1 - Materials and Equipments

Materials:

1. 100 pieces of waste paper
 - o Newspaper, office paper, cardboard, etc.
2. 2 liters of Water

Equipment:

1. 1 Blender *what blender?*
2. 1 stainless steel pipe mixing sticks
 - o 23.5 inches
3. 1 Buckets or Large Containers
 - o Height: 11 inches
 - o Width: 12.5 inches
 - o 16 liters
4. Drying area or racks
5. 1 Stainless steel cooking pot
 - o Height: 5 inches
 - o Width: 9 inches
 - o 5 liters
6. 2 Stopwatches

7. Proper PPE (Full clothing, gloves, and masks)
 - Full clothing: long sleeve and jeans/pants that covers the leg)
 - Surgical and heat resistant glove
 - Surgical mask

Equipment (Calorimeter):

1. 1 big and 1 small cans
 - Cali can (330 ml)
 - Paint can (1 liters)
2. 1 barbecue stick (10 inches)
3. 1 mercury thermometer
4. 1 lighter

Section 2 - Procedures

A. Gathering of Materials

The conversion of paper waste into eco-friendly paper briquettes involves a systematic approach that includes gathering materials, preparing the paper, and utilizing appropriate tools and safety measures. This procedure helps create sustainable energy solutions in addition to encouraging recycling.

- **Gathering Paper** - gather appropriate paper materials in order to transform waste paper into environmentally friendly paper briquettes. Then, locate sources for paper goods like newspapers, cardboard, and educational institutions. Gather these resources, making sure the assortment is varied.

- **Sorting Paper** - sort the gathered paper to get rid of any unwanted substances that could interfere with the burning process and could lower the quality of the paper briquettes, like adhesives and plastic coatings. A pure and effective final product is guaranteed by careful sorting.

B. Soaking and Shredding of Paper

Soaking the Paper

- **Purpose** - by soaking the paper in water, it allows the fibers to break down and form a pulp, which will later be shaped in briquettes.
- **Process** - the soaking ratio is *Mass of Papers:Liters of Water (1 kg of paper waste:0.5 Liters of water)*. Generally, a minimum of several hours is the recommended duration of the soaking process. In some cases, soaking the paper for up to a week is utilized to ensure the paper becomes optimally saturated, resulting in a thick, mushy consistency. However, the researchers' study will use a 24-hour duration for the soaking period. These pulps will be used for shaping into briquettes.

Shredding the Paper

- **Purpose** - by shredding the paper it breaks down into smaller pieces, making it easier to process into briquettes.
- **Process** - the paper will be shredded using a blender, effectively grinding the paper into bits. Shredding the paper using a blender is suggested by some practitioners for efficiency and availability according to the Ready Nutrition

Website. This process breaks down the paper fibers and prepares them for the next step.

C. Forming into Briquettes

After soaking and shredding the paper will now go through the briquetting process.

- **Compressing the Shredded Paper** - After being shredded and soaked overnight, the soaked paper is compressed to remove excess water. Compressing paper into dense blocks increases its energy density, causing the paper to burn more slowly and steadily, resulting in a longer-lasting and more efficient heat source.
- **Shaping the Briquettes** - the compressed paper is shaped into round solid briquettes. This form allows for efficient drying and easier handling.

D. Drying of the Briquettes

Once the paper has been shaped into briquettes, the paper is now then left to dry.

- **Sun Drying** - the briquettes are placed in a drying rack with direct sunlight. This drying process may take several days depending on the weather. Proper drying is an important factor in this process, as it ensures the briquettes burn efficiently without producing excessive smoke.
- **Final Product** - After the drying process, the briquettes can now be used as an eco-friendly alternative for the traditional wood charcoal.

Calorimeter Procedure

1. **Get a small metal can.** This can will be used to contain water that will be heated as part of the calorimetric measurements. Any small metal can will work, such as those used to

package vegetables, or a soda can. Make sure that it is empty, clean, and open on one end.

If you are using a soda can, the opening used for drinking out of the can will suffice.

2. **Get a larger metal can.** You will need a second metal can, large enough that the small metal can will fit inside it with room to spare. Any larger metal can will work, such as a coffee can. Make sure that it is empty, clean, and open on both ends.
3. **Puncture four small holes in the small can.** Using a hole punch, ice pick, or other implement, carefully puncture four small holes (each one directly across from another) in the small metal can. Position the holes just below the rim of the open end of the can.
4. **Slide two thin rods between the four holes in the can.** Slide one barbecue stick through the can to the other side, then repeat with the other rod and the two remaining holes; the two rods should cross each other. These rods will be used to support the small can in the calorimeter. Temperature-resistant glass rods are ideal. If you do not have any, try any kind of sturdy, nonflammable rod.
5. **Fill the small can with water.** Using a graduated cylinder, flask, or other container, pour 100 mL of distilled water in the small metal can.
6. **Measure the temperature of the water.** Using a mercury thermometer (not a digital one), take the initial temperature of your water. You may need to leave the thermometer in the water for some time so that it can get an accurate reading of the water (which may change temperature as it adjusts to room temperature).
7. **Place the small can inside of the larger one.** The small metal can should rest securely inside the larger one, supported by the rods made of glass or another nonflammable material.

Paragraph

Data Gathering

state technically

For this study, the researchers will use a ~~qualitative and quantitative~~ research design. The aim of the study is to assess the effectiveness and feasibility of using paper waste as an alternative fuel source. The researchers will conduct a series of tests on the product to gather data, repeating the experiments **15 times** to ensure accuracy and consistency in the results.

The researchers will measure three (3) important aspects: **burning time**, **heat output**, and **smoke emissions**. Burning time will be recorded using a **timer** to track how long the paper briquettes can contain a fire. A fire can be started by igniting a lighter and spreading the fire to the paper briquettes. **Heat output** will be measured using a **mercury thermometer**. The paper briquettes will be utilized as the heat source, and then boiling water temperature is measured by the thermometer to determine the heat output. For **smoke emissions**, the researchers will rely on **observation and survey methods**, where respondents will assess the smoke levels during the burning process. The researchers will utilize a 5 point likert scale as a survey tool.

To gather community feedback, **15 household respondents** will be surveyed. These participants will evaluate the smoke emissions compared to the traditional wood charcoal using a **Likert scale** being placed in a survey form. The survey responses will be used to measure the public's reaction or fondness on the environmental and practical implications of using paper briquettes, specifically its potential as a cleaner alternative to traditional charcoal. The Likert scale will allow the researchers to identify respondent perceptions of smoke emissions, providing insight into the product's overall environmental impact. The survey questionnaire is adopted and modified from a study published by Siao (n.d.) entitled, "Coconut Waste to Charcoal Briquette."

Response Categories	Numerical Value
---------------------	-----------------

Significantly Higher	5
Slightly Higher	4
Similar	3
Slightly lower	2
Significant lower	1



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Annexes

Survey

Dear Respondent,

Greetings!

You are invited to participate in a study titled "**Transforming Paper Waste into Paper Briquettes: A Sustainable and Eco-friendly Alternative for Fuel.**" The goal of this study is to explore the conversion of paper waste into paper briquettes, providing an environmentally friendly substitute for traditional wood-charcoal.

Your participation, through answering the survey questionnaire, is crucial to the success of this research. Your honest and thoughtful responses will significantly contribute to achieving the study's objectives. Participation is completely voluntary, and you are free to withdraw at any time without penalty.

Rest assured that your privacy and the confidentiality of your answers will be fully protected. All information provided will be used solely for statistical analysis, and only the researcher and study advisers will have access to the data. Identifying information will be replaced with codes to ensure anonymity.

Additionally, the findings of this study will be published in a scientific journal accessible in various libraries. In the publication, participants will be referred to in broad categories such as administrators, teachers, and students. All questionnaires will be securely stored after the study is completed.

If you have any questions, please feel free to contact us at jeconiahsduran@su.edu.ph.

Thank you for your participation and support.

Sincerely,

Mary Louise Abecia

Jeconiah Ella Duran

Mardie Gabriel Erojo

Veronica Jade Macatiguib

Ethan Kyle Nacua

Tracy Rose Quimosquimos

Tyrah Louise Sanchez

**"TRANSFORMING PAPER WASTE TO PAPER BRIQUETTES: A SUSTAINABLE AND
ECO-FRIENDLY ALTERNATIVE FOR FUEL"**

Name (Optional): _____

Address: _____

Age: _____

Instructions: For each statement below, please select and mark the option that best reflects your observation of the smoke emission in comparison between paper briquettes and traditional wood charcoal. Please be guided with this table in answering the survey questions.

Response Categories	Numerical Value
Significantly Higher	5
Slightly Higher	4
Similar	3
Slightly lower	2
Significant lower	1

1. Amount of smoke emitted during ignition (Paper briquettes compared to traditional wood charcoal)

Response Categories	Numerical Value	Rating
Significantly Higher	5	
Slightly Higher	4	
Similar	3	
Slightly lower	2	
Significant lower	1	

2. Amount of smoke emitted during sustained burning (Paper briquettes compared to traditional wood charcoal)

Response Categories	Numerical Value	Rating
Significantly Higher	5	
Slightly Higher	4	
Similar	3	
Slightly lower	2	
Significant lower	1	

3. Amount of smoke emitted after the paper briquette is almost consumed (Paper briquettes compared to traditional wood charcoal)

Response Categories	Numerical Value	Rating
Significantly Higher	5	
Slightly Higher	4	
Similar	3	
Slightly lower	2	
Significant lower	1	

4. Visual thickness of the smoke (Paper briquettes compared to traditional wood charcoal)

Response Categories	Numerical Value	Rating
Significantly Higher	5	
Slightly Higher	4	
Similar	3	
Slightly lower	2	
Significant lower	1	

5. Overall perception of smoke emission of the paper briquettes compared to traditional wood charcoal

Response Categories	Numerical Value	Rating
Significantly Higher	5	
Slightly Higher	4	
Similar	3	
Slightly lower	2	
Significant lower	1	

Thank you for your participation! Your responses will contribute valuable insights to our research.